

## A POWER QUALITY IMPROVED BRIDGELESS KY CONVERTER BASED COMPUTER POWER SUPPLY

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**Abstract**— This project introduces a design, analysis, simulation and improvement of power factor (PF) multiple output Switched Mode Power Supply (SMPS) using a bridgeless KY converter is used as the first stage. The first stage buck-boost converter is designed in Discontinuous Conduction Mode (DCM) for inherent power factor correction (PFC). Comparing with conventional topologies the proposed topology reduces conduction losses and improves power quality. Both simulation and experimental results demonstrate the improved performance of the proposed SMPS.

**Keywords**—Bridgeless converter, PFC, input current, computer power supply, KY converter.

### 1. Introduction

Many electronic appliances powered up from the utility utilize the classical method of ac-dc rectification which involves a diode bridge rectifier (DBR) followed by a large electrolytic capacitor. The uncontrolled charging and discharging of this capacitor instigates a harmonic rich current being drawn from the utility which goes against the international power quality standard limits. Modern ac-dc converters incorporate power factor correction (PFC) and harmonic current reduction at the point of common coupling (PCC) which improves voltage regulation and efficiency at the load end. Personal computer is one of the electronic equipment which is severely affected by power quality problems. Single stage and two stage conversion of ac voltage into dc voltage have been used in computers to maintain harmonic content within limits and also to obtain stiffly regulated multiple outputs.

Single stage power conversion is simple, compact and cost-effective. However, it suffers from poor dynamic response, control complexity, high capacitance value and high component stress. So, two stage conversion of ac voltage into multiple dc voltages is mostly preferred in computers. The component count of the two stage power supply is high in

comparison to its single stage counterpart; also, it provides better output voltage regulation, fast dynamic response and blocks the 100Hz component in the first stage itself so that large capacitors at the output side are avoided. Various front end converters have been employed in the power supplies for providing PFC and output voltage regulation. A boost converter is the common choice for providing PFC in power supplies.

However, it is not the preferred choice in computer power supplies due to its large input voltage range. The output voltage of a boost converter cannot be controlled to a value less than 300V for a 220V ac input supply. Therefore, buck-boost converter is preferred in computers where wide variations in input voltages and load are expected. The efficiency of a two stage SMPS is lower than the conventional SMPS; to eliminate this disadvantage, a new bridgeless front end converter is proposed in this paper for computer power supplies. The elimination of DBR at the front end results in reduced conduction losses and large output voltage range with enhanced efficiency. At the output of the front end converter, a half bridge converter is used which provides isolation, regulation and multiple dc outputs. The half bridge converter is a common choice because it offers better core utilization. It is observed from the available literature that the power quality improvement in SMPSs using bridgeless PFC converter has not been attempted by many researchers so far.

## **2. Literature Survey**

### **1. A KY Boost Converter**

A KYboost converter is presented, which is the KY converter combined with the traditional synchronously rectified (SR) boost converter. Such a converter has continuous input and output inductor currents, different from the traditional SR boost converter, and has a larger voltage conversion ratio than the traditional SR boost converter does, and hence, this converter is very suitable for low-ripple applications. A detailed description of the proposed converter is presented herein along with a mathematical deduction and some experimental results.

The proposed KY boost converter has higher voltage conversion ratio than the traditional SR boost converter does. Besides, the input and output inductor currents are continuous, different from the traditional SR boost converter, and hence, this converter is very suitable for low-ripple applications. As for the efficiency, this converter has the efficiency of 90% or more above the half load. Indeed, the proposed converter is suitable for the small-power applications because the surge current created by the charge pump is indispensable. But, using the soft switching with surge current suppressed can overcome this problem, and hence, makes this converter likely to be operated in high-power applications[1].

### **2. A Front-End Converter with High Reliability and High Efficiency**

This paper presents a front-end converter including a novel bridgeless PFC converter with high reliability and an isolated full-bridge DC-DC converter with a proposed control scheme to improve efficiency under a light load condition. The proposed bridgeless PFC converter can avoid flowing a high inrush current to silicon carbide Schottkydiodes and MOSFETs without impairing efficiency. Furthermore, efficiency of full bridge DC-DC converters under a light load condition can be improved by adjusting to proper switching

frequency. In this paper, the proposed  $x$  topologies and the principles of operation are introduced.

This paper introduced a high reliability and high efficiency front-end converter using a novel bridgeless PFC converter and a full bridge DC-DC converter with the proposed control scheme. The experimental results verified that the proposed PFC converter can avoid flowing high inrush current to silicon carbide Schottky barrier diodes and MOSFETs without impairing efficiency. Moreover, the efficiency of the full bridge DC-DC converter under a light load condition was improved by the proposed control scheme. Finally, high efficiency of the front-end converter was obtained over a wide output power range [2].

### 3. Existing Method

A boost converter provides PFC in power supplies. However, it is not the preferred choice in computer power supplies due to its requirement for a large input voltage range. The output voltage of a boost converter cannot be controlled to a value less than 300V for a 220V ac input. So, a buck-boost converter is preferred in PCs where wide variations in input voltages and load are expected. Low output voltage ripple is preferred in a computer power supply as it is connected to various IC's. Single stage power supplies are used in many applications where power quality improvement and voltage regulation take place in a single stage. However, in computers, single stage configuration increases the stress across the switches and slows the voltage regulation under varying loads.

### 4. Proposed Method

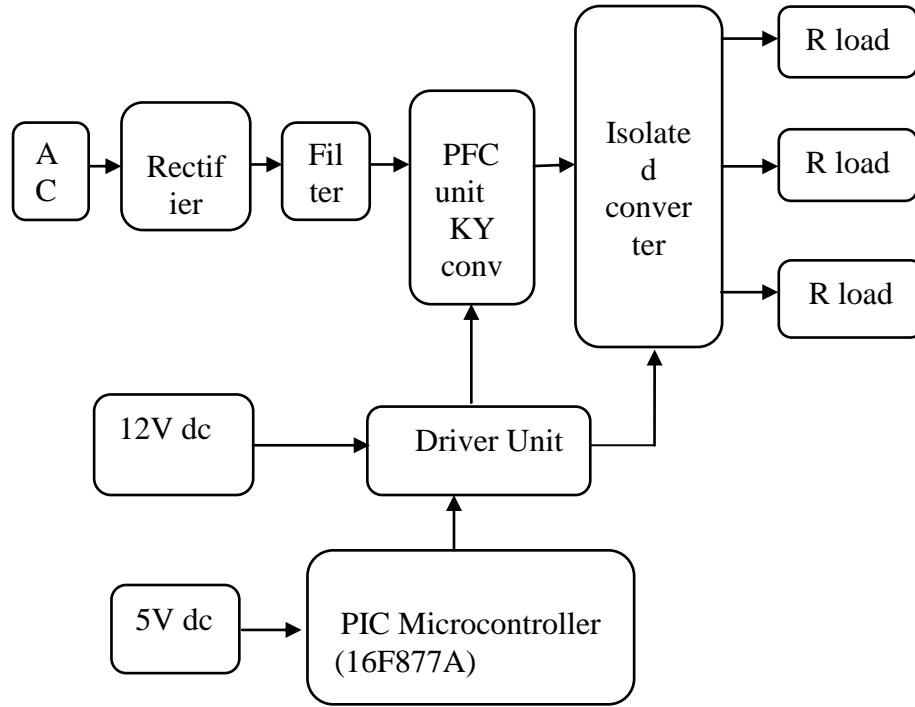
KY converter is a step up dc-dc converter. It is invented by the Mr. K. I Hwu and Y. T Yau. Hence, it is called as KY converter. It is a boost converter. It contains two power switches, one power diode, one energy transferring capacitor and output capacitor and inductor. The voltage conversion ratio of basic KY converter is  $1+D$ , which is higher than that of traditional boost converter and buck-boost converter.

For further improving the voltage gain, one coupled inductor is incorporated to the basic KY converter. In addition to the high voltage gain, the proposed converter possesses very small output voltage ripple and the output current is non-pulsating. Besides, the output voltage polarity is same as that of input voltage polarity. Again to increase voltage gain voltage multiplier cell is incorporated with the converter circuit.

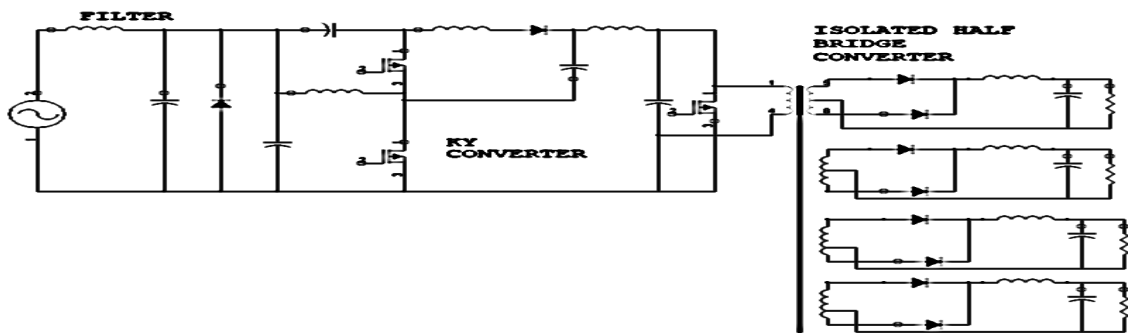
This project introduces a design, analysis, simulation and improvement of power factor (PF) multiple output Switched Mode Power Supply (SMPS) using a bridgeless KY converter as the first stage. The first stage buck-boost converter is designed in Discontinuous Conduction Mode (DCM) for inherent power factor correction (PFC). The proposed converter operates in the positive current mode.

That is, the currents flowing through the magnetizing inductor  $L_m$  and the output inductor  $L_o$  are always positive. The dead times between the two MOSFET switches are omitted. The MOSFET switches and the diode are assumed to be ideal components. The values of all the capacitors are large enough such that the voltages across them are kept

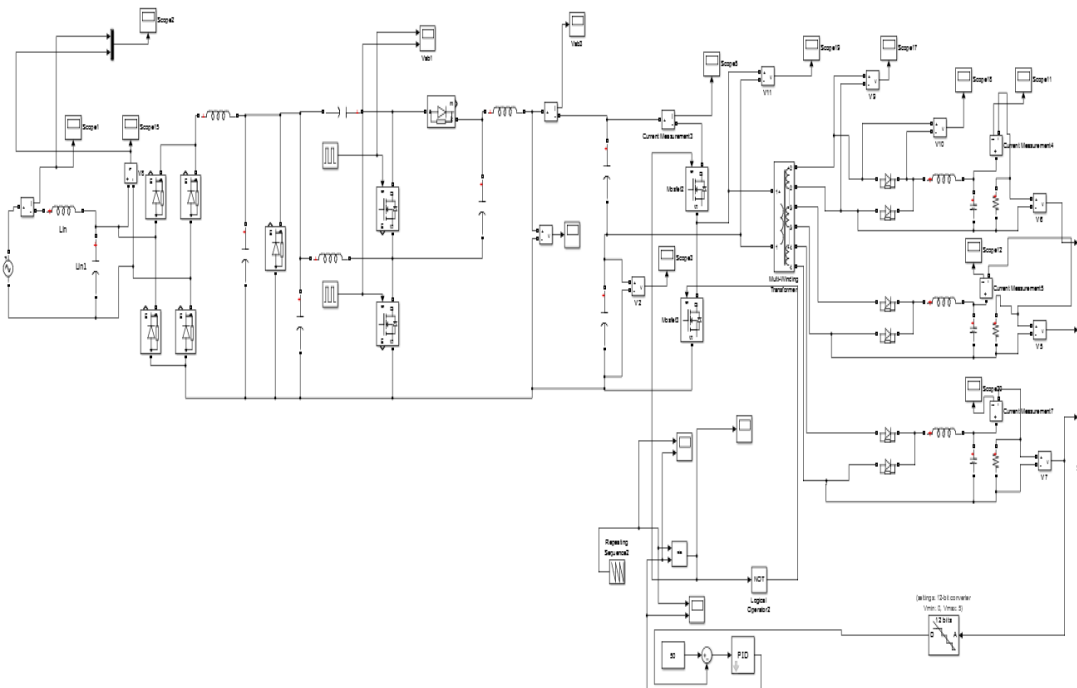
constant at some values. The magnitude of the switching ripple is negligible. Therefore the small ripple approximation will be adopted in the following analysis.



**Fig.1 Block Diagram for Bridgeless KY Converter**



**Fig.2 Circuit diagram for Bridgeless KY Converter**



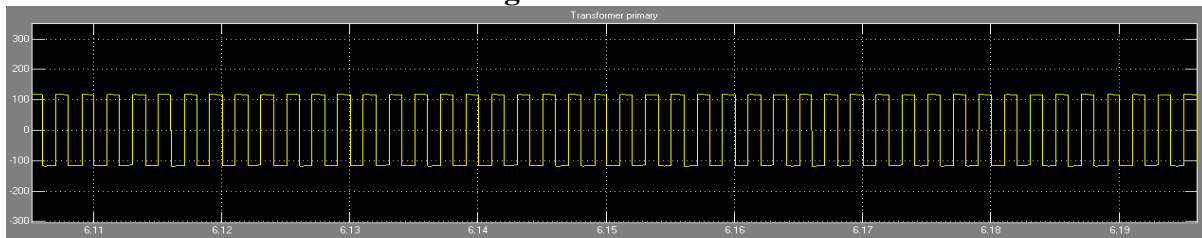
**Fig.3 Simulation diagram for Bridgeless KY Converter**

### 5. Comparative analysis

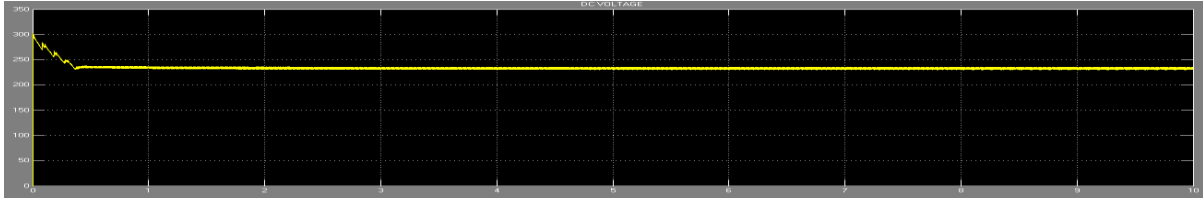
Comparing with conventional topologies the proposed topology reduces conduction losses and improves power quality. Both simulation and experimental results demonstrate the improved performance of the proposed SMPS. The proposed KY boost converter has higher voltage conversion ratio when compared with the traditional SR boost converter.



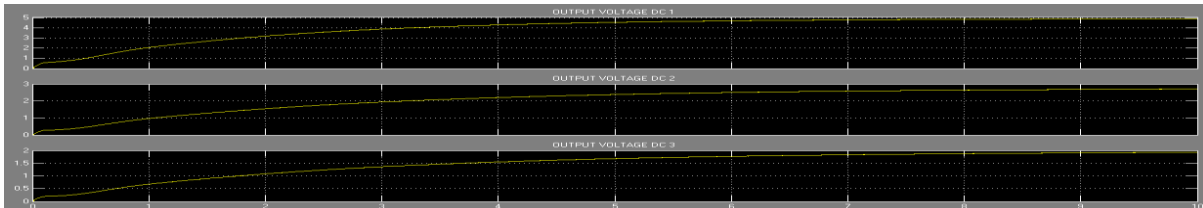
**Fig.4 Power Factor**



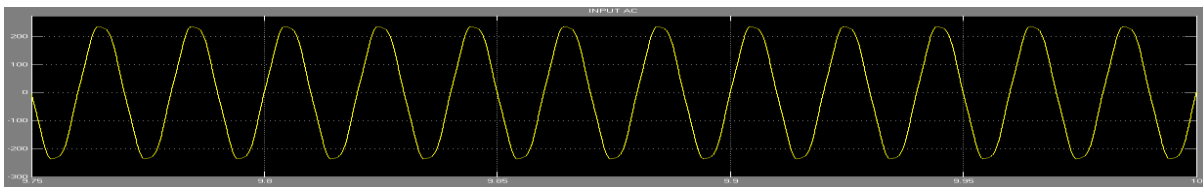
**Fig .5 Transformer Primary**



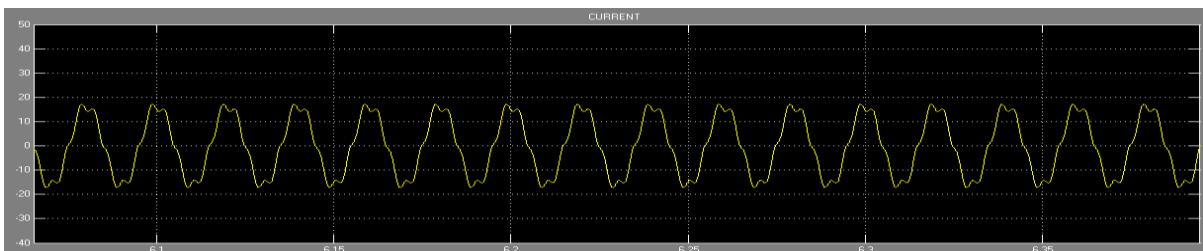
**Fig.5 DC Voltage**



**Fig.6 Output Voltage DC1, DC2 & DC3**



**Fig.7 Input AC**



**Fig.8 Current**

## 8. Conclusion

A bridgeless KY converter based power supply has been proposed here to mitigate the power quality problems prevalent in any conventional computer power supply. The proposed power supply is able to operate satisfactorily under wide variations in input voltages and loads. The design and simulation of the proposed power supply is initially carried to demonstrate its improved performance. Further, a laboratory prototype is built and experiments are conducted on this prototype. Test results obtained are found to be in line with the simulated performance. They corroborate the fact that the power quality problems at the front end are mitigated and hence, the proposed circuit can be a recommended solution for computers and other similar appliances.

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